

CLAIMS

I/We claim:

- [c1] 1. An apparatus for launching an unmanned aircraft, comprising:
a launch guide structure having a launch axis;
a launch carriage movably carried by the launch guide structure for movement along the launch axis, the launch carriage being configured to releasably carry an unmanned aircraft during takeoff;
an energy reservoir configured to provide energy to the launch carriage to accelerate the launch carriage and receive energy from the launch carriage to decelerate the launch carriage; and
a transmission coupled between the energy reservoir and the launch carriage to transmit energy between the energy reservoir and the launch carriage.
- [c2] 2. The apparatus of claim 1 wherein the transmission includes a first portion coupled to the energy reservoir to receive a first force from the energy reservoir and accelerate with a first acceleration, the transmission further including a second portion coupled to launch carriage to impart a second force and a second acceleration to the launch carriage, wherein the second force is different than the first force and the second acceleration is different than the first acceleration.
- [c3] 3. The apparatus of claim 1 wherein the transmission includes a first portion coupled to the energy reservoir to receive a first force from the energy reservoir and accelerate with a first acceleration, the transmission further including a second portion coupled to launch carriage to impart a second force and a

second acceleration to the launch carriage, wherein the second acceleration is greater than the first acceleration.

[c4] 4. The apparatus of claim 1 wherein the transmission includes a first portion coupled to the energy reservoir to receive a first force from the energy reservoir and accelerate with a first acceleration, the transmission further including a second portion coupled to launch carriage to impart a second force and a second acceleration to the launch carriage, wherein the second acceleration is at least approximately four times the first acceleration.

[c5] 5. The apparatus of claim 1 wherein the launch carriage is positioned to carry at least one of a fuselage and a lifting surface of the aircraft.

[c6] 6. The apparatus of claim 1, further comprising:
an extendable boom having a longitudinal axis, wherein the launch guide structure is carried by the extendable boom, and wherein the launch axis extends at least approximately parallel to the longitudinal axis of the boom; and
a flexible recovery line carried by the extendable boom, the flexible recovery line having an intercept portion positioned to intercept the unmanned aircraft in flight.

[c7] 7. The apparatus of claim 1 wherein the launch guide structure includes a rail positioned along the launch axis and the launch carriage is movably carried by the rail.

[c8] 8. The apparatus of claim 1 wherein the energy reservoir includes at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a weight.

- [c9] 9. The apparatus of claim 1 wherein the energy reservoir includes at least one constant force spring.
- [c10] 10. The apparatus of claim 1 wherein the transmission includes a cable and a plurality of pulleys arranged in a block and tackle configuration.
- [c11] 11. The apparatus of claim 1, further comprising the aircraft.
- [c12] 12. The apparatus of claim 1 wherein the launch carriage is configured to accelerate from a first position to a second position during launch and decelerate to a third position after launch, and wherein:
the energy reservoir has a first energy level when the launch carriage is in the first position;
the energy reservoir has a second energy level less than the first level when the launch carriage is in the second position; and
the energy reservoir has a third energy level higher than the second energy level and lower than the first energy level when the launch carriage is in the third position.
- [c13] 13. An apparatus for launching an unmanned aircraft, comprising:
a launch guide structure having a launch axis;
a launch carriage movably carried by the launch guide structure for movement along the launch axis, the launch carriage being configured to releasably carry at least one of a fuselage and a lifting surface of an unmanned aircraft during takeoff;
an energy reservoir configured to provide energy to the launch carriage;
and
a transmission coupled between the energy reservoir and the launch carriage to transmit energy between the energy reservoir and the launch carriage.

- [c14] 14. The apparatus of claim 13 wherein the transmission is coupled between the energy reservoir and the launch carriage to transmit energy from the energy reservoir to the launch carriage as the launch carriage accelerates and transmit energy from the launch carriage to the energy reservoir as the launch carriage decelerates.
- [c15] 15. The apparatus of claim 13, further comprising:
an extendable boom having a longitudinal axis, wherein the launch guide structure is carried by the extendable boom and wherein the launch axis extends at least approximately parallel to the longitudinal axis of the boom; and
a flexible recovery line carried by the extendable boom, the flexible recovery line having an intercept portion positioned to intercept the unmanned aircraft in flight.
- [c16] 16. The apparatus of claim 13 wherein the launch guide structure includes a rail positioned along the launch axis and the launch carriage is movably carried by the rail.
- [c17] 17. The apparatus of claim 13 wherein the energy reservoir includes at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a weight.
- [c18] 18. The apparatus of claim 13 wherein the transmission includes a cable and a plurality of pulleys arranged in a block and tackle configuration.
- [c19] 19. The apparatus of claim 13, further comprising the aircraft.
- [c20] 20. An apparatus for launching an unmanned aircraft, comprising:
a launch guide structure having a launch axis;

a launch carriage movably carried by the launch guide structure for movement along the launch axis, the launch carriage being configured to releasably support at least one of a fuselage and a lifting surface of an unmanned aircraft during takeoff;
an energy reservoir configured to provide energy to the launch carriage;
and
a transmission having a first portion coupled to the energy reservoir and a second portion coupled to the launch carriage, the first portion being configured to accelerate at a first acceleration when receiving a first force from the energy reservoir, the second portion being configured to impart a second force and a second acceleration to the launch carriage, wherein the second force is different than the first force and the second acceleration is different than the first acceleration.

[c21] 21. The apparatus of claim 20 wherein the transmission is configured to impart to the launch carriage a second acceleration greater than the first acceleration.

[c22] 22. The apparatus of claim 20 wherein the transmission is configured to impart to the launch carriage a second acceleration at least approximately four times the first acceleration.

[c23] 23. The apparatus of claim 20, further comprising:
an extendable boom having a longitudinal axis, wherein the launch guide structure is carried by the extendable boom and wherein the launch axis extends at least approximately parallel to the longitudinal axis of the boom; and
a flexible recovery line carried by the extendable boom, the flexible recovery line having an intercept portion positioned to intercept the unmanned aircraft in flight.

- [c24] 24. The apparatus of claim 20 wherein the launch guide structure includes a rail positioned along the launch axis and the launch carriage is movably carried by the rail.
- [c25] 25. The apparatus of claim 20 wherein the energy reservoir includes at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a weight.
- [c26] 26. The apparatus of claim 20 wherein the transmission includes a cable and a plurality of pulleys arranged in a block and tackle configuration.
- [c27] 27. The apparatus of claim 20, further comprising the aircraft.
- [c28] 28. An apparatus for launching an unmanned aircraft, comprising:
an extendable boom having a first portion and a second portion, with at least one of the first and second portions being movable relative to the other along a longitudinal axis between a retracted position and an extended position;
a launch guide structure having a launch axis extending at least approximately parallel to the longitudinal axis of the boom;
a launch carriage having an aircraft support positioned to releasably carry at least one of a lifting surface and a fuselage of an unmanned aircraft, the launch carriage being movably carried by the launch guide structure for movement along the launch axis during takeoff of the unmanned aircraft;
an energy reservoir configured to provide energy to the launch carriage during acceleration of the launch carriage and receive energy from the launch carriage during deceleration of the launch carriage; and
a transmission having a first portion coupled to the energy reservoir and a second portion coupled to the launch carriage, the first portion being configured to accelerate at a first acceleration when receiving a first

force from the energy reservoir, the second portion being configured to impart a second force and a second acceleration to the launch carriage, wherein the second force is different than the first force and the second acceleration is different than the first acceleration.

[c29] 29. The apparatus of claim 28, further comprising a flexible recovery line carried by the extendable boom, the flexible recovery line having an intercept portion positioned to intercept the unmanned aircraft in flight.

[c30] 30. The apparatus of claim 28 wherein the launch guide structure includes at least one launch rail positioned generally parallel to the launch axis and the launch carriage is movably supported by the launch rail.

[c31] 31. The apparatus of claim 28 wherein the energy reservoir includes at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a weight.

[c32] 32. The apparatus of claim 28 wherein the transmission includes a cable and a plurality of pulleys arranged in a block and tackle configuration.

[c33] 33. The apparatus of claim 28, further comprising the aircraft.

[c34] 34. The apparatus of claim 28 wherein the launch carriage is configured to accelerate from a first position to a second position during launch and decelerate to a third position after launch, and wherein:

the energy reservoir has a first energy level when the launch carriage is in the first position;

the energy reservoir has a second energy level less than the first level when the launch carriage is in the second position; and

the energy reservoir has a third energy level higher than the second energy level and lower than the first energy level when the launch carriage is in the third position.

[c35] 35. An apparatus for launching an unmanned aircraft, comprising:
carriage means for carrying an unmanned aircraft during launch;
support means for supporting and guiding the carriage means along a launch axis during launch;
energy reservoir means for transferring energy to and from the carriage means; and
transmission means coupled between the energy reservoir means and the launching means to impart energy to the carriage means during acceleration of the carriage means and return energy from the carriage means to the energy reservoir means during deceleration of the carriage means.

[c36] 36. The apparatus of claim 35 wherein the support means include:
an extendable boom having a first portion and a second portion, with at least one of the first and second portions being movable relative to the other along a longitudinal axis between a retracted position and an extended position; and
a launch guide structure carried by the extendable boom, the launch guide structure including the launch axis extending at least generally parallel to the longitudinal axis of the extendable boom.

[c37] 37. The apparatus of claim 35 wherein the carriage means are positioned to carry at least one of a lifting surface and a fuselage of the unmanned aircraft along the launch axis during takeoff.

[c38] 38. The apparatus of claim 35 wherein the energy reservoir means include at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an

electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a weight.

[c39] 39. The apparatus of claim 35 wherein the transmission means include a cable and a plurality of pulleys arranged in a block and tackle configuration.

[c40] 40. A method for launching an unmanned aircraft, comprising:
releasably carrying an unmanned aircraft with a launch carriage;
accelerating the aircraft along a launch axis by transferring energy from an energy reservoir to the launch carriage;
decelerating the launch carriage by transferring energy from the launch carriage to the energy reservoir; and
releasing the aircraft from the launch carriage for flight.

[c41] 41. The method of claim 40 further comprising:
reducing an energy level of the energy reservoir from a first level to a second level by accelerating the launch carriage from a first position to a second position; and
increasing an energy level of the energy reservoir from the second level to a third level by decelerating the launch carriage from the second position to a third position.

[c42] 42. The method of claim 40 wherein transferring energy from an energy reservoir includes transferring energy from at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a falling weight.

[c43] 43. A method for launching an unmanned aircraft, comprising:
releasably carrying an unmanned aircraft by supporting at least one of a fuselage and a lifting surface of the aircraft with a launch carriage;

activating an energy reservoir to produce a first force and a first acceleration;
converting the first force to second force different than the first force and
converting the first acceleration to a second acceleration different than the first acceleration;
accelerating the aircraft along a launch axis at the second acceleration by imparting the second force to the launch carriage; and
releasing the aircraft from the launch carriage for flight.

[c44] 44. The method of claim 43, further comprising decelerating the launch carriage by transferring energy from the launch carriage to the energy reservoir after imparting the second force and second acceleration to the launch carriage and before releasing the aircraft from the launch carriage for flight.

[c45] 45. The method of claim 43 wherein converting the first force to the second force includes decreasing the first force to the second force, and wherein converting the first acceleration to the second acceleration includes increasing the first acceleration to the second acceleration.

[c46] 46. The method of claim 43 wherein activating an energy reservoir includes activating at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, an electric motor, a flywheel, a steam-powered apparatus, an explosive charge, and a falling weight.

[c47] 47. The method of claim 43 wherein converting the first acceleration to the second acceleration includes operating a block and tackle.

[c48] 48. A method for launching an unmanned aircraft, comprising:
releasably carrying an unmanned aircraft by supporting at least one of a fuselage and a lifting surface of the aircraft with a launch carriage;

activating an energy reservoir to produce a first force and a first acceleration;
converting the first force to second force different than the first force and
converting the first acceleration to a second acceleration different than the first acceleration;
accelerating the aircraft along a launch axis at the second acceleration by imparting the second force to the launch carriage;
decelerating the launch carriage by transferring energy from the launch carriage to the energy reservoir; and
releasing the aircraft from the launch carriage for flight.

[c49]

49. The method of claim 48 wherein:
the energy reservoir has a first energy level before activation;
activating the energy reservoir to produce the first force and first acceleration includes removing energy from the energy reservoir until the energy reservoir has a second energy level less than the first energy level; and
decelerating the launch carriage further includes transferring energy from the launch carriage to the energy reservoir until the energy reservoir has a third energy level greater than the second energy level and less than the first energy level.

[c50]

50. The method of claim 48 wherein converting the first force to the second force includes decreasing the first force to the second force, and wherein converting the first acceleration to the second acceleration includes increasing the first acceleration to the second acceleration.